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the documents annexed hereto are true copies of:

Application forms P.1 and P.2, provisional specification and drawings  
of South African Patent Application No. 2001/5458 as originally  
filed in the Republic of South Africa on 3 July 2001 and post-dated  
to 3 January 2002 in the name of NXCO INTERNATIONAL LIMITED for  
an invention entitled: "A CARTRIDGE FOR BREAKING ROCK HAVING A  
BASE DIRECTED STRESS CONCENTRATOR".

Geteken te  
Signed at PRETORIA in die Republiek van Suid-Afrika, hierdie  
in the Republic of South Africa, this

15th

dag van  
day of May 2003

1  
Registrateur van Patente  
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PATENTS ACT, 1978

*Post-dated*  
REGISTRAR OF PATENTS

Official Application No.			Lodging date: Provisional			Acceptance date:	
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International classification			Lodging date: Complete			Granted date:	
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Full name(s) of applicant(s)/Patentee(s)							
71	NXCO INTERNATIONAL LIMITED						

Applicant(s) substituted:						Date Registered:
71						

Assignee(s):						Date Registered:
71						

Full name(s) of inventor(s)							
72	To be advised						

Priority claimed	Country		Number		Date	
Note:	33	NONE	31	NONE	32	NONE
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Abbreviation for Country	33		31		32	

Title of Invention:							
54	A CARTRIDGE FOR BREAKING ROCK HAVING A BASE DIRECTED STRESS CONCENTRATOR						

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Patent of Addition No.		Date of any change:					
61							

Fresh Application based on:		Date of any change:					

REPUBLIC OF SOUTH AFRICA  
PATENTS ACT, 1978

APPLICATION FOR A PATENT AND ACKNOWLEDGEMENT OF  
RECEIPT  
(Section 30(1) - Regulation 22)

The grant of a patent is hereby requested by the undermentioned applicant on the basis of the present application filed in duplicate

OFFICIAL APPLICATION NO.

21 01 20015458

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WORLD TRADE CENTER JOHANNESBURG	
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FULL NAME(S) OF APPLICANT(S)

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TITLE OF INVENTION

54 A CARTRIDGE FOR BREAKING ROCK HAVING A BASE DIRECTED STRESS CONCENTRATOR

Priority is claimed as set out on the accompanying Form P2.

The earliest priority claimed is :

This application is a patent of addition to Patent Application No.

21 01

This application is a fresh application in terms of section 37 and based on Application No.

21 01

THIS APPLICATION IS ACCOMPANIED BY:

- |   |    |  |
|---|----|--|
| X | 1  | A single copy of a provisional specification of 9 pages                  |
|   | 2  | Two copies of a complete specification of ..... pages                    |
| X | 3  | 1 sheets of Informal Drawings  |
|   | 4  | ..... sheets of Formal Drawings  |
|   | 5  | Publication particulars and abstract (Form P8 in duplicate)              |
|   | 6  | A copy of Figure ..... of drawings (if any) for the abstract             |
|   | 7  | Assignment of Invention  |
|   | 8  | Certified priority document(s) Number(s)                                 |
|   | 9  | Translation of priority document(s)                                      |
|   | 10 | An assignment of priority rights   |
|   | 11 | A copy of the Form P2 and the specification of SA Patent Application No. |
|   | 12 | A declaration and power of attorney on Form P3                           |
|   | 13 | Request for ante-dating on Form P4                                       |
|   | 14 | Request for classification on Form P9                                    |
| X | 15 | Form P2 in duplicate   |

21 01

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Dated this 3<sup>rd</sup> day of July 2001.

McCALLUM, RADEMEYER & FREIMOND  
PATENT AGENTS FOR APPLICANT(S)

REGISTRAR OF THE COURT OF THE COMMISSIONER OF PATENTS	
3-1-2002	
2001-07-11 3	
REGISTRAR OF PATENTS PATENTS OFFICE REPUBLIC OF SOUTH AFRICA	

Par Gallo

REPUBLIC OF SOUTH AFRICA  
PATENTS ACT, 1978

**PROVISIONAL SPECIFICATION**

(Section 30(1) - Regulation 27)

OFFICIAL APPLICATION NO

21	01	20015458
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LODGING DATE

*Post-dated*

22	3.1.2002. 3 JULY 2001
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FULL NAME(S) OF APPLICANT(S)

71	NXCO INTERNATIONAL LIMITED
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FULL NAME(S) OF INVENTOR(S)

72	To be advised
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TITLE OF INVENTION

54	A CARTRIDGE FOR BREAKING ROCK HAVING A BASE DIRECTED STRESS CONCENTRATOR
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BACKGROUND OF THE INVENTION

This invention is concerned generally with a customized low energy method of breaking rock in a controlled manner.

As used herein the word "rock" includes rock, ore, coal, concrete and any similar hard mass, whether above ground or underground, which is difficult to break or fracture. It is to be understood that "rock" is to be interpreted broadly.

A number of techniques have been developed for the breaking of rock using non-explosive means. These include a carbon dioxide gas pressurisation method (referred to as the Cardox method), the use of gas injectors (the Sunburst technique), hydrofracturing and various methods by which cartridges containing energetic substances pressurise the walls or base of a sealed drill hole to produce penetrating cone fractures (known as PCF).

These techniques may be an order of magnitude more efficient than conventional blasting in that they require approximately 1/10 of the energy to break a given amount of rock compared to conventional blasting using high explosives. The lower energy reduces the resulting quantity of fly rock and air blast and to an extent allows the rockbreaking operation to proceed on a continuous basis as opposed to the batch-type situation which prevails with conventional blasting.

Most non-explosive rockbreaking techniques rely on the generation of high gas pressures to initiate a tensile fracture at the bottom or sides of a relatively short drill hole.

Efficient confinement of the gas produced in the hole is a prerequisite for  
5 ensuring that the available energy is effectively used to break the rock.

Problems with confining the gas in the hole arise with current methods of non-explosive breaking due often to the jointed or fractured nature of the rock in its natural state.

A jointed rock with open joints that traverse the drill hole in the rock will tend  
10 to terminate any cracks that are propagated by high-pressure gas toward the open joint by dissipating the gas pressure in the cracks at the intersection of the open joint. The result is that in a hole which is relatively long, where open joints are present, there is a difficulty in fragmenting the rock effectively over the length of the hole.

15 Attempts to deck the hole with separate charges of energetic substance separated by plugs of stemming run into the problem that each pressurised portion of the hole must develop a breaking point in the rock in order to propagate cracks. Due to the relatively low pressure environment which prevails in the hole when use is made of propellants (compared to the high  
20 pressure environments which exist with explosives), it is not always possible for the pressurised sections of the hole to create new cracks in the rock with the result that the pressure in the hole tends to dislodge its confining

stemming material to form a "blow-out" of the stemming through the collar of the hole.

Thus, if the hole can be pressurised in separate sections and each of the pressurised sections can act independently to break its respective section of the hole, the problem of premature termination of crack propagation and the problem of blow-outs can be overcome or alleviated. An object of the present invention is to achieve such a result.

#### SUMMARY OF INVENTION

According to the invention a method of breaking rock includes the steps of:

- (a) loading a cartridge into a hole in a rock face;
- (b) confining the cartridge in the hole;
- (c) initiating a propellant in the cartridge thereby to cause the release of pressurised material,
- (d) supporting a base of the cartridge to prevent the base from fracturing under the effect of the pressurised material, and
- (e) directing the pressurised material at least to a periphery of the base to initiate breakage of rock adjacent the periphery.

In one form of the invention the cartridge is supported at a bottom of the hole.

In an alternative embodiment the cartridge is supported inside the hole at a location which is spaced from the bottom of the hole. The cartridge may be

supported, for example, on stemming. With this form of the invention the base of the cartridge is thus separated from the bottom of the hole.

A plurality of cartridges may be used inside the hole. Thus a first cartridge may be positioned at a first location at or near a bottom of the hole and a second cartridge may be positioned at a second location in the hole which is spaced from the first location. Third or even fourth cartridges may be employed according to requirement.

Stemming may be positioned inside the hole between successive cartridges.

According to a different aspect of the invention there is provided a method of breaking rock which includes the steps of:

- (a) supporting a plurality of cartridges at respective locations in a hole in a rock face, the respective locations being spaced from each other in an axial direction of the hole,
- (b) igniting propellant in the respective cartridges thereby to cause the release of pressurised material inside each cartridge, and
- (c) at each location directing force which is generated by the respective pressurised material onto a respective surface of a wall of the hole at or near a base of the respective cartridge.

The invention also provides apparatus for breaking rock which includes a cartridge with a base and a side wall which form an enclosure, and a propellant inside the enclosure, and wherein a discontinuous relatively weaker region of the container is formed at a junction between the wall and the base.

The cartridge may be generally cylindrical in shape and the base may be substantially at right angles to a longitudinal axis of the cartridge.

The base may be substantially more robust than the wall of the container and to achieve this the base may be made from a stronger or thicker material than  
5 the wall.

In one embodiment of the invention the base is shaped to direct a wave of the pressurised material towards its periphery. This may be achieved in any appropriate way and, for example, the base, on an internal surface, may be substantially conical in shape.

10 BRIEF DESCRIPTION OF THE DRAWING

The invention is further described by way of example with reference to the accompanying drawing which illustrates from the side and in cross section the use of the method of the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

15 The accompanying drawing illustrates a hole 10 which is formed in rock 12 by drilling from a rock face 14 using conventional drilling machines and techniques which are not further described herein.

The hole 10 has a length 16 and a diameter 18. The hole has a bottom 20 which, ideally, is substantially at right-angles to side walls 22 of the hole. It is  
20 to be noted however that this ideal is rarely reached in practice for due to

wear of the bit which is used for drilling the hole 10 or poor operator technique the "corners" 26 between the bottom 20 and the wall 22 are often concave in shape with the result that the bottom 20 is normally at least slightly rounded.

A cartridge 30 is loaded into the hole so that its base 32 is in contact with the  
5 bottom 20 of the hole. The cartridge is made from any appropriate material, such as, for example, a high density plastics material. The cartridge includes a side wall 34 which extends upwardly from the base 32 and which is generally of circular cylindrical shape. At an upper end the cartridge 30 is domed in shape.

10 The base 32 has a thickness 38 which is significantly greater than the thickness 40 of the wall 34. The base 38 is therefore substantially more robust than the wall 40. The cartridge is filled with a propellant 42 which can be ignited by means of an initiator 44, of known construction, which is engaged within the cartridge. Control wires 46 lead from the initiator 44 to a  
15 control unit which is used for controlling the breaking operation. The control unit is of a type which is known in the art and consequently is not further described herein.

As used herein "propellant" is to be interpreted broadly to include a propellant, blasting agent, explosive, gas-evolving substance, or similar means which,  
20 once initiated, generates high pressure material typically at least partly in gaseous form. Propellants of this nature are known in the art. Propellant and blasting agent are used interchangeably.

Stemming 50 is positioned inside the hole 10 over the cartridge 30 to a desired extent. Thereafter a cartridge 52 is loaded into the hole, resting on the underlying stemming. The amount of stemming 50 placed in the hole is such that the cartridge 52 is consequently supported inside the hole at a 5 desired spacing from the lower cartridge 30.

It is apparent that further cartridges can be supported inside the hole, according to the length of the hole and blasting requirements. The present invention is however described with reference to the use of two cartridges inside the hole but this is a non-limiting example.

10 The cartridge 52 is in many respects similar to the cartridge 30 and components which are the same as components in the cartridge 30 bear identical reference numerals and are not further described.

15 It is to be noted however that the base of the cartridge 52, designated 32A, is substantially conical in cross section with an apex 54 of the cone extending into the interior of the cartridge at a central location thereof.

Stemming 56 is placed over the cartridge 52 and tamped in position.

20 The propellants 42 in the various cartridges are ignited substantially simultaneously by means of control signals applied through the wires 46 to the respective initiators 44. Ignition of the propellants causes the release of high pressure jet material, substantially in gaseous form, in each of the cartridges.

- In respect of the cartridge 30 the base 32 is forced downwardly by the high pressure jet material expanding inside the cartridge interior and is driven into close contact with the bottom 20 of the hole. Due to the robust nature of the base gas inside the cartridge is prevented from venting directly onto the 5 bottom 20. The gas is instead directed towards the right angled junction 60 between the walls 34 and the base 32 which, at least due to its shape, is discontinuous and therefore constitutes a line of weakness. The junction 60 could, if desired, be deliberately weakened by reducing the quantity of material which is used at the junction.
- 10 The base 32 thus provides a solid surface which, at least initially, is gas impermeable and the high pressure gas thus fractures the junction 60 and is thereby directed into that portion of the wall 26 which surrounds the junction. Fracture of the wall is thereby induced or initiated at this region.
- 15 In respect of the cartridge 52 the base 32A is, as before, significantly robust and is also forced by the high pressure jet material expanding inside the confinement structure constituted by the cartridge onto the underlying stemming 50. The stemming 50 in conjunction with the base 32A effectively defines a "false" bottom of the hole, insofar as the cartridge 52 is concerned. The high pressure material inside this cartridge is then directed by the conical 20 upper surface of the base 32A towards the peripheral region 26A of the base which, as before, is discontinuous or weakened so that pressure release takes place, at least initially, at this region. The gas which is released at the

side wall, in the region of the periphery of the base, fractures the rock at this region.

The invention thus provides a technique whereby the wall of a relatively elongate hole, in the rock face, can be fractured at two or more points which are spaced from one another by inducing localised stresses at these points.

5 At locations other than the bottom of the hole the localised stresses result from creating a "false" hole bottom by using a robust base of the cartridge which is supported by means of the underlying stemming and which is shaped to direct the pressurised material, released by the ignited propellant, towards the surrounding wall of the hole to cause its fracture.

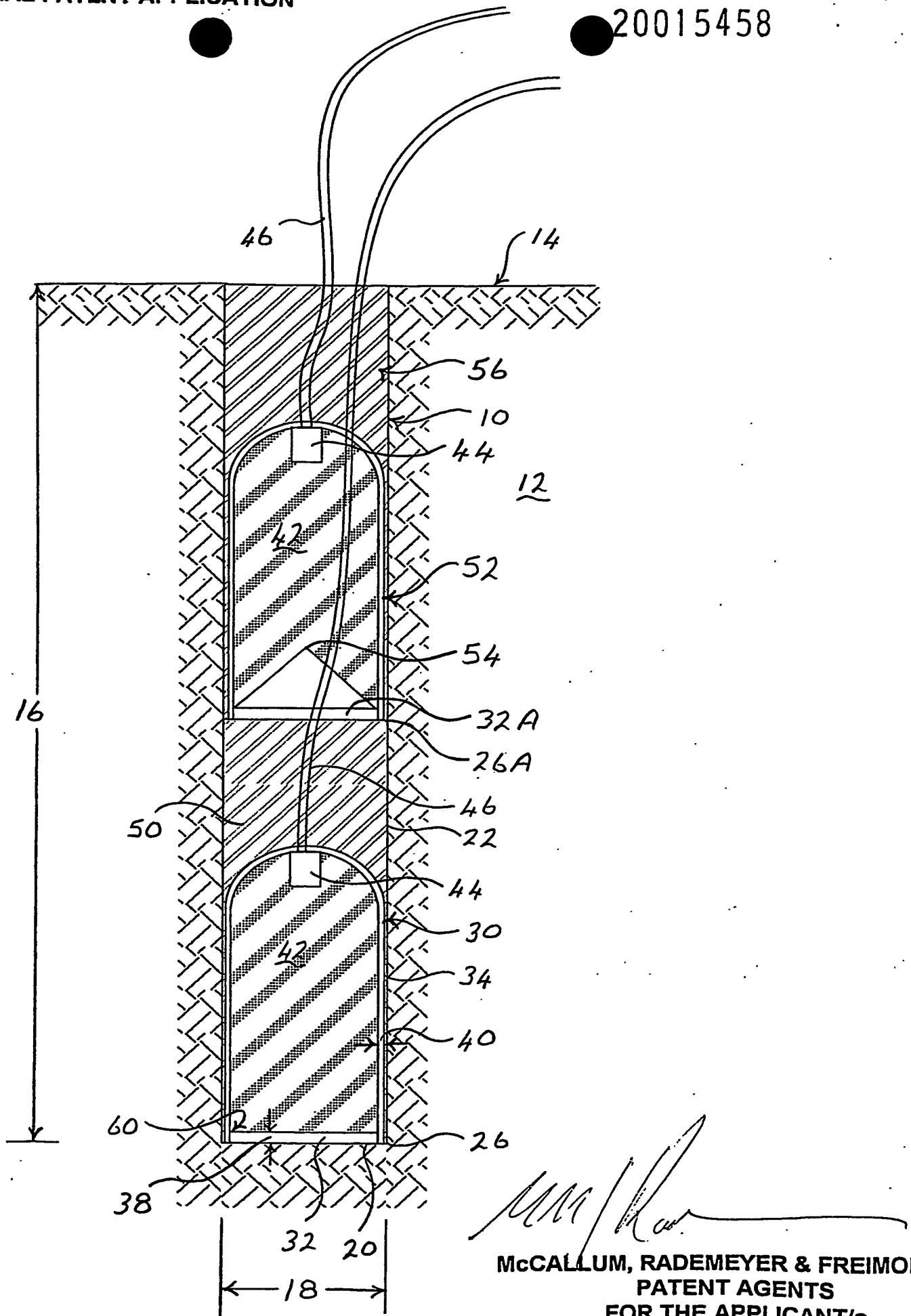
10

A principal benefit of the method of the invention is that a relatively large amount of rock over an extended hole distance can be released in a manner which makes efficient use of propellant and which allows cycle times for blasting and clearing to be contained.

15 Dated this 3<sup>rd</sup> day of July 2001.



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McCALLUM, RADEMEYER & FREIMOND  
Patent Agents for the Applicant



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